Building a 3D View of the Orion Star-Forming Region

Paper by
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2D to 3D

Young star cluster
Orion A
Orion B
Orion Lamda

2D dust map
3D dust shell model
2D to 3D

Young star cluster
Orion A
Orion B
Orion Lambda

2D dust map
3D dust shell model
2D dust ring model
Orion B
Orion A
Orion Lambda
Young star cluster
3D dust shell model
2D dust ring model
expansion center

2D to 3D
Where are supernovae?

- Orion A
- Orion B
- Orion Lambda
- Young star cluster
- 2D dust map
- 3D dust shell model
- 2D dust ring model
- Supernova Tracer
What made Barnard’s Loop?

- Young star cluster
- Orion A
- Orion B
- Orion Lambda
- 3D dust shell model
- 2D dust map
- 2D dust ring model
- Supernova Tracer
- Barnard’s Loop
Estimate of Gravitational Contribution to Current Stellar Velocities

Dense gas pulling on stars!

Closer to dense material

Farther from dense material

We can calculate how Anisotropic gravitational acceleration is reflected in motions of the stars
When Were Supernova Explosions?

Given the properties of any star cluster, we can estimate when supernovae would explode. The cluster in Orion likely produced 1-2 supernovae within the last few million years.
A 3D View of Orion: I. Barnard’s Loop

Abstract

Barnard’s Loop is a famous arc of hydrogen-alpha emission located in the Orion star-forming region. Here, we provide evidence of a possible formation mechanism for Barnard’s Loop and compare our results with recent work suggesting a major feedback event occurred in the region around 6 Myr ago. We expand on the discovery of a coherent, radial, 3D expansion of the OB3-Near/Briceno-1 (OBP-B1) cluster at the center of Barnard’s Loop from Swiggum et al. 2021. This cluster appears to serve as another possible center for expansion of a number of young clusters identified in Grossschedl et al. 2021, which previously attributed the expansion center to Orion X. 3D dust mapping is used to characterize the 3D topology of the entire region, which shows Barnard’s Loop’s correspondence to a roughly spherical 3D cavity around the OB3-B1 cluster. Simple estimates of gravitational effects from both stars and gas indicate that gravitational feedback from the gas and dust may have strongly affected the kinematics of the stars in OBP-B1. We conclude that it is likely that at least one supernova occurred in the OBP-B1 cluster and played a major role in shaping the region.

Stay tuned for submission to ApJ June 2022

Check out the preprint!
https://tinyurl.com/orion3d
What can this tell us about star formation?

Stars may be “dragged” by dense material in expanding shells.

All three molecular clouds appear to lie along the edge of the 3D dust shell. This strongly suggests that supernovae may be triggering star formation in Orion.

Orion needed many supernovae to reach its current state.

Supernovae from OBP-B1 likely played a major role in the formation of Barnard’s Loop.